THE EFFECT ON STUDENT PERFORMANCE OF WEB-BASED LEARNING AND HOMEWORK IN MICROECONOMICS

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ABSTRACT

For most students, economic logic is a new and challenging way of looking at social and commercial activity which is difficult for many to grasp. University principles texts today typically rely on simplified abstract models and problems to develop skills in concepts and principles. They then make use of numerous examples of these principles in action in the form of journalistic reports, historical examples, or simple case studies to improve students' critical thinking skills in applying these new concepts and ways of thinking in a more realistic setting of actual events. The opportunity to provide many more learning options, mandatory homework, instant feedback, easier assessment and incentives for completion using a technology with which many more students are familiar and comfortable seemed very appropriate to enhance the teaching of economics.

A survey of literature on the use of mandatory homework and web-based (online) learning systems has shown a mix of outcomes in a variety of subjects. Most of these studies have set up control groups and tested homework assignments that were mandatory or optional, traditional paper or online, etc. We recognized the potential value of web-based learning systems and adopted one for our microeconomics courses. Our analysis is designed to test the effect of the mandatory use of a web-based learning system on quiz and exam scores in microeconomic principles courses. This analysis is not against a control group but an endogenous test of the effect on exam and quiz scores of using the various tools available within the system on an individual student basis.

INTRODUCTION

For many students, economics is a rather unique and unusual way of looking at the world and human behavior. Economic logic is a type of critical thinking itself about social activities and commercial issues. Grasping the key principles and effectively applying them to understanding individual and firm behavior is very challenging and considered difficult. Although economics is a social science, it is more often compared with mathematics and physics with regard to degree of difficulty. Many students therefore enter an economics course with a predisposition about its difficulty which must be overcome as well.

University principles texts today typically rely on simplified abstract models and problems to develop skills in concepts and principles. They then make use of numerous examples of these principles in action in the form of journalistic reports, historical examples, or simple case studies to improve students' critical thinking skills in applying these new concepts and ways of thinking in a more realistic setting of actual events. The opportunity to provide many more learning options, mandatory homework, instant feedback, easier assessment and incentives for completion using a technology with which many more students are familiar and comfortable seemed very appropriate to enhance the teaching of economics.

For many years, the authors had been teaching economics using the traditional "chalk-and-talk" lecture format and showing sample problems in class to improve students' understanding of concepts and ability to solve homework and test problems. We used varying degrees of homework assignments, in-class quizzes, and exams to measure student performance, provide feedback, and encourage staying current with the material we were covering. Exams were often adjusted for degree of difficulty from previous experience to get average scores that students were comfortable with in order to minimize the risk of adverse effects on student evaluations of teaching performance.

These circumstances lead us to recognize the potential value of web-based assignments to expand learning opportunities and provide more consistent and immediate feedback. Previously we were only able to post solutions to homework problems, without sufficient classroom time to review the details. It was very time-consuming to grade homework with sufficient individual feedback to help students improve their weaknesses. Web-based homework programs allowed for potential solutions to both these teaching problems. These online programs also offered additional resources such as study guides and practice tests.

OVERVIEW OF RELATED RESEARCH

A review of research on the performance of students using varying forms of homework and assignments suggested a very mixed bag of results. Many of the studies on web-based homework have been in math and science courses, but a few have analyzed economics courses. One study conducted in a calculus class on the use of mandatory homework showed no significant improvement from a class in which problems were assigned but were not collected and graded. Yet most studies suggest or assume that homework that provides feedback and creates motivation for students should be effective. Gutarts and Bains (2010) point out that a drawback of mandatory homework is that it becomes the only effort used to study. If so, then students are giving up on other means of improving their understanding just to meet the homework requirement. Our attempt to investigate the effects of an online homework system takes advantage of immediate feedback and the motivation of knowing the homework counts significantly toward their course grade.

Another study reports that homework incentives do improve performance. This study was conducted in a required major course in organizational psychology in which instructors graded oral presentations without knowledge of whether homework was required or not. The results suggested that there was a significant difference in performance in the group that had specific incentives to complete the assignments. (Radhakrishnan, 2009) The authors attributed the improvement to students being more attentive to homework because of the incentives. They also reported that the loss of marks on assignments was more of a motivator than gains from bonus. Incidentally, we have not seen this type of response with our students but we have not attempted to measure it explicitly.

There have been many recent studies on web-based homework again with mixed conclusions. For example, a study of first year math students controlled between a web-based homework and traditional paper homework. They measured no significant difference on exam scores although the students using web-based homework were somewhat more likely to attempt the assignments which improved their course score. (Lenz, 2010)

Exam scores in a college algebra course were reportedly improved for students using online homework compared to traditional paper homework. The authors used a Pearson/Addison-Wesley product called *CourseCompass,* which employed extensive hints, allowed multiple attempts, and provide instant feedback much like the homework system used in this study. (Burch, 2010) However, the students' scores on the paper homework assignments were actually a better predictor of exam performance. Burch and Kou also noted better student retention rates for online assignments as compared to paper.

Another interesting study examined the use of web-based homework compared to an ungraded paper homework control group. Their results indicated that the students using web-based homework did at least as well as the control group and better on the "less-complex, skill-based calculations". (LaRose, 2010) These results are unclear though because the skills test was administered online so the control group may have been at a disadvantage with regard to using the system. Nevertheless, students were more aware of the amount of homework they were attempting when it was graded and counted as opposed to ungraded. Interestingly the amount of homework completed in this study correlated with overall GPA which complicates the real effect of the online system on course performance.

One key element we wish to exploit is "more time" as a measure of level of effort on the homework assignments. Finally, online homework has the benefit of allowing more class time allocated to new material rather than just reviewing old homework. Given the amount of material that is traditionally expected to be covered in a university economic principles course, the class time issue has always been a limiting factor.

Students now are generally more comfortable with using new technologies, so implementing them for class assignments and performance evaluation is a logical progression. Student satisfaction with these new web-enhanced technologies is another element researchers are interested in evaluating because of its expected impact on success. Hermans, Haytko, and

Mott-Stenerson examined three particular issues with regard to this issue. They looked at the effect of student satisfaction with their instructor, the ease of system use, and satisfaction with the course itself. All three of the variables correlated significantly but they noted that ease of use does not necessarily mean that students fully accept the technology. (Hermans, 2009)

One critical issue from this study with regard to our system is that no social interaction is allowed. Students highly value interaction, so just access to doing homework online may not help them accept the technology. Discussion boards, real-time interaction, and other forms of student connections may be more appealing to students. The Hermans, et al study was focused on developing distance learning courses; however the traditional university classroom setting using online supplements must still maintain close interaction with students to enhance satisfaction.

Another study by Demirci is of importance with regard to evaluating online homework performance. Demirci investigated student performance and perceptions using a control group for a web-based physics course. His results indicate that there is no significant difference in performance on concept tests. The first semester students actually showed a significant improvement for the control group using tradition paper homework. However, students' perceptions of the online homework were favorable. (Demirci, 2010)

A few other variables or issues are reported in some other studies. Mandatory attendance reduced absenteeism and improved exam scores in economics courses. (Marburger, 2006) The magnitude of this improvement was only about two percent compared to a no attendance policy control group. Student behavior was examined in economics courses and found to be significant. (McClure, 2003) Indicators of student disinterest during an instructor's lecture were correlated with poorer performance. However, the author noted that measures of boorish or rude behavior were not correlated with performance.

Finally, a variety of characteristics of web-based learning systems for accounting courses were evaluated by Pergola and Walters, 2011. They did not attempt to describe the significance of each feature of the system but they are pointing the relative desirability to aid the instructor in choosing a system for their course. This study leads to the conclusion that many other characteristics of online courses, web-based systems, and homework programs can impact student success and satisfaction and have not yet been carefully examined. Our effort is to contribute something to this diverse and difficult topic regarding teaching and helping our students.

METHOD AND DATA

Most of the studies referenced in this paper have used traditional control groups as a means of testing the significance of various factors as explained earlier. Since there were mixed results from the literature on whether mandatory or online homework contributed to conceptual learning and we had already decided to add an online homework system to our principles

courses, we wanted to address another question. If we use an endogenous control for other factors related to student performance within the courses we had established, could we detect an improvement in exam scores based on the use of the online homework? Our exams are currently the standardized measure of conceptual knowledge for our courses. If we could detect an improvement, then a future study using a traditional control group may further confirm our results.

Our data was collected over a five semester period from students enrolled in 20 sections of Principles of Microeconomics and includes 924 observations. The population of these principles sections is approximately 90% business students. They are generally traditional students classified as sophomores, although a few juniors and freshmen are not unusual. The variables collected for each student in our data set include exam scores, online quiz scores, online homework scores as well as time spent online with the publisher's software. All of these quizzes and homework assignments are mandatory in that they are included in overall course grade. We also have data on time spent on the individualized study plans and practice tests which are optional assignments. Time spent on assignments is interpreted as a proxy variable for student effort or engagement on the assignments both individually and cumulatively. For each student enrolled in these sections we have also collected their overall GPA for all college work and ACT score which is used to control for academic abilities. We also compiled their grade in their college algebra course which is used specifically to control for mathematical aptitudes. A table of summary statistics is included in the appendix.

For each chapter that is covered, students are expected to complete one homework set defining new terms and general concepts and another homework set that focuses more on problem solving, graphing, and calculations. After completing these two assignments they can then open and work the chapter quiz. Each of these assignments is a 10-point assignment included in the final course grade. The homework assignments can be worked as many times as the student wishes with hints and links to the text for help. Only their best attempt is counted. This policy is designed to provide a compelling incentive for completing the homework assignments for the points even if they are still having trouble with the material and subsequent exams. This incentive is consistent with that documented in Radhakrishnan, et.al. (2009). Students must receive a score of at least 70% on the homework assignment before they are allowed to open the quiz assignment for that chapter. The quiz assignment has a limited time period within which to complete and may only be attempted once.

Our initial instinct is that the use or appropriate use of online assignments and supplements will result in improved exams scores and course performance. We have formed several basic hypotheses from working with this system of assignments. First, with regard to homework assignments, since each can be attempted multiple times, the final scores would not likely reflect the student's true comprehension of the material. However, time spent on these assignments would likely represent a level of effort or commitment in order to comprehend the material before moving on to the quizzes. Level of effort was considered a significant factor in

the reviewed literature. (Gutarts and Bain, 2010; Burch, 2010) Second, because quizzes could only be attempted once, we expected that the quiz scores should correspond closely with overall comprehension of the material and therefore with exam scores. Finally, we presumed that student performance based on exam scores would be linked to their overall intellectual ability. We wanted to be able to control for this ability in order to test for improvements in performance linked to doing assignments beyond their general intellectual ability.

The two measures that were available as indicators of intellectual or scholastic ability were ACT scores and cumulative GPA. These variables are correlated. However they do measure somewhat different types of ability. Overall ACT scores are generally the result of accumulated ability to work standardized problems quickly and accurately whereas cumulative GPA measures success in individual courses which is more likely a combination of ability and effort. Many less intellectually gifted students overcome their impediments by hard work and extra effort which could also be captured in the GPA. We had no reason to presume that one variable was theoretically better for this application than the other and allowed our data to indicate which had more statistical power.

RESULTS

A full description of the variables which are referred to in this section is provided in the appendix as an Index of Variable Names. The variable names referred to specifically in the tables of the regressions of this section are added in brackets to aid the reader.

Our first model confirms the hypothesis that cumulative GPA [gpa] and quiz scores [qavg] are significantly correlated with exam scores [exam] as shown in Table 1. As a matter fact, both the average score on quizzes as well as the amount of time spent completing quizzes were both statistically significant in predicting exam scores (results not shown), again indicating that students' ability and effort are contributing to more success on the quizzes and then on exams. This result is not surprising as we described above.

However, our interest lies more in how the homework assignments and other tools available were promoting student performance. To address this issue we ran two additional models which are shown in Table 2 and Table 3 below. These models include the amount of time spent in the program on homework assignments [hwtime], using the study plan [sptime] for follow up on questions students answered incorrectly, and extra time spent [xtime] on practice tests, eBook, video segments, and other tools available. We included student's GPA as our ability control variable in one model and student's ACT score [act] as the control in the other. For reasons described earlier, GPA was preferred over ACT. The coefficient on GPA was about seven times higher than for ACT. Also, student scores in their college algebra course was a statistically better control than ACT for these economics courses (results not shown).

Table 1: First Regression Model
regress exam gpa qavg

Source	ss	df	MS		Number of obs =	842
Model	73695.8702	2	36847.9351		F(2, 834) =	244.14
Residual	125875.829	834	150.93025		Prob > F =	0
					R-squared =	0.3693
					Adj R-squared =	0.3678
Total	199571.699	836	238.722128		Root MSE =	12.285

exam	Coef.	Std. Error	t	P>t	[95% Conf.	Interval]
gpa	6.885	0.7331	9.39	0.000	5.4456	8.3234
qavg	0.352	0.0266	13.24	0.000	0.2995	0.4038
_cons	26.510	1.8280	14.5	0.000	22.9219	30.0980

The model using GPA as a control was a more statistically powerful model as indicated by the F-statistic. From the results of these two models, we made two important observations from our data. First, that time spent on homework was not significant in predicting better exams scores. Second, that study plan time spent and extra time spent were both statistically significant although their coefficients were not very high. In the model in Table 2, one extra hour spent on the study plan, practice tests, etc. would result in just less than one extra point earned on the exam.

Table 2: Second Regression Model
regress exam gpa hwtime sptime xtime

Source	S.S.	df	MS		Number of obs =	870
Model	54323.84	4	13580.9607		F(4, 865) =	75.99
Residual	154597.38	865	178.725295		Prob > F =	0
					R-squared =	0.26
Total	208921.223	869	240.415677		Adj R-squared =	0.2566
					Root MSE =	13.369

exam	Coef.	Std. Error	t	P>t	[95% Conf.	Interval]
gpa	11.016	0.7030	15.67	0.000	9.6357	12.3955
hwtime	-0.103	0.1088	-0.95	0.342	-0.3169	0.1102
sptime	0.949	0.3092	3.07	0.002	0.3421	1.5558
xtime	0.871	0.3593	2.43	0.016	0.1661	1.5767
_cons	35.780	1.8111	19.76	0.000	32.2251	39.3343

Table 3: Third Regression Model
regress exam act hwtime sptime xtime

Source	S.S.	df	MS		Number of obs =	745
Model	34782.7159	4	8695.67897		F(4, 740) =	47.93
Residual	134240.889	740	181.406607		Prob > F =	0
					R-squared =	0.2058
					Adj R-squared =	0.2015
Total	169023.605	744	227.182265		Root MSE =	13.469

exam	Coef.	Std. Error	t	P>t	[95% Conf.	Interval]
act	1.651	0.1342	12.3	0.000	1.3872	1.9143
hwtime	0.134	0.1160	1.15	0.249	-0.0940	0.3615
sptime	1.530	0.3613	4.23	0.000	0.8207	2.2394
xtime	1.383	0.3802	3.64	0.000	0.6369	2.1296
_cons	28.041	2.8218	9.94	0.000	22.5018	33.5811

The model using GPA as a control was a more statistically powerful model as indicated by the F-statistic. From the results of these two models, we made two important observations from our data. First, that time spent on homework was not significant in predicting better exams scores. Second, that study plan time spent and extra time spent were both statistically significant although their coefficients were not very high. In the model in Table 2, one extra hour spent on the study plan, practice tests, etc. would result in just less than one extra point earned on the exam.

DISCUSSION

The results from our data on homework time were not surprising. Although we would like to show that more time spent on homework improved exam scores, a few factors make that difficult to observe. In our courses, the homework assignments were mandatory and they could be worked multiple times. If the homework exercises were not completed then it would not be possible to earn enough points to pass the course. Since homework can be attempted multiple times, a perverse incentive is created for some students to simply click through the questions as quickly as possible. They could then use the feedback from the program to repeat the questions again until they achieved an acceptable score. While the points earned for the homework increased the motivation to complete, it did not necessarily create the motivation to comprehend the material. So one drawback of this system is that the homework might become the only source of study for many students, assuming that would sufficiently prepare them for exams. (Gutarts and Bains, 2010) This possibility would certainly diminish the effects of predicting exam scores based on homework performance.

The study plan and other practice tools available for preparation in the program were not mandatory. Students that are ambitious enough to use these tools were gaining a small but statistically significant improvement in exam scores and presumably quiz scores as well. Using these tools in the program is the real level of effort that can impact learning that is referred to in the literature. (Lenz, 2010; Burch and Kuo, 2010)

In order to better understand our results we have also encouraged students to provide feedback through student evaluations of teaching or by other means. As one might expect, comments vary from "online homework is very helpful" and "love MyEconLab" to "online quizzes are nothing like the homework; much harder". Generally, comments run favorable for the homework system by about four or five to one.

Because of some comments that the quizzes were harder, we did a simple check. For some chapters we switched the homework assignment that contained mostly problems with calculations or graphs with the quiz assignment for that same chapter. The results of this switch had no apparent effect on the average score for that quiz. We concluded that the time constraint on the quiz, as well as some students' lack of real effort to prepare, was affecting their perception of the difficulty.

The publisher, Pearson, provided us with some information form a marketing report on MyEconLab. Their results on over 275,000 student surveys in 2010 indicated that 90% of students felt that the system's assignments, study plan, and practice questions with feedback had helped them to better prepare for tests. Also, 84% reported that they would recommend MyEconLab to their friends.

CONCLUSION

Although much of the literature has indicated mixed results on the use of mandatory homework, we have concluded that an online system of exercises has been beneficial to our students. The results of our analysis suggest that an increased level of effort using the tools provided in the online program can statistically significantly improve exam scores. The magnitude of these improvements is small but additional studies may allow for an investigation of different types of assignments that may be more effective. A follow up investigation using a traditional control group may make it possible to measure the effects compared to other homework methods.

Our sample population is not random. These students have self-selected into our sections for a variety of unknown reasons. This selection process certainly limits the interpretation, so our results may not apply equally to all other student populations (i.e. other types of schools, regions, disciplines, etc.). Our study only investigates the use of the software program in microeconomics courses. Application to other disciplines and sub-disciplines may not be appropriate but is consistent with other studies in mathematics, science, and other quantitative classes. The lack of other measures of mastering skills certainly limits the interpretation of these

results. The use of exams scores as the measure the conceptual knowledge gained in the course could be improved upon. Despite the limitations these results do provide some guidance for understanding how online homework programs may improve student performance.

We intend to explore whether we can better design our courses and also collect and organize our data to examine its effects further. Designing assignments that promote good performance on the exams is a challenge of its own, but this system has still allowed us to provide students with useful exercises and more immediate and effective feedback than would otherwise have been possible using traditional written homework or in-class quizzes. Our observation is consistent with David Colander's statement in the preface to his economic principles textbook. "I strongly believe that most students have the ability to understand economic concepts even though on exams it often appears as if they have serious problems. In my opinion, many of those problems are not conceptual; rather, they are problems in motivation, reading, and math." (Colander, 2008, v) Difficulty on economics exams seems to be a consistent reality for many students. Today's students use computer technology as an everyday part of their lives. We will continue to use these online tools to better challenge and motivate our students to improve and to promote more effective ways of teaching the economic way of thinking.

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APPENDIX

Table 4: Summary Statistics

Variable	Observations	Mean	Std. Dev.	Minimum	Maximum
gpa	920	2.5058	0.6801	0.49	4.00
act	787	20.3266	3.6736	11	35.00
ca	666	2.1396	1.1064	0	4.00
hwtime	924	3.7515	4.1617	0	61.29
hwavg	879	92.8764	14.6928	0	120.00
qtime	924	1.3849	0.9617	0	5.44
qavg	861	57.4058	18.1984	0	97.57
sp	924	9.5563	29.8061	0	215.00
sptime	924	0.4179	1.4600	0	17.97
xtime	924	0.2960	1.2540	0	27.26
ttime	924	5.8504	5.3171	0	62.89
exam	874	63.9325	15.5235	18	103.00

Table 5: Index of Variable Names

Variable	Description of Variables
gpa	Cumulative University GPA (4 point scale)
act	Highest Recorded ACT Score
ca	Score in College Algebra
hwtime	Cumulative time spent on Homework Assignments
hwavg	Average Score on Homework Assignments
qtime	Cumulative time spent on Quiz Assignments
qavg	Average Score on Quiz Assignments
sp	Dummy variable indicating use of Study Plan
sptime	Cumulative time spent on Study Plan
xtime	Cumulative time spent on Extra Practice Tests
ttime	Total time spent using Publisher's Software
exam	Average Score on Course Exams in class